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SOME CHANGES IN THE COMPOSITION OF CALIFORNIA AVOCADOS DURING GROWTH.

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THE CALIFORNIA AVOCADO INDUSTRY.

Avocado growing is still one of the infant industries of California. Although many single trees or small groups of trees have been in existence for some time, real attempts at commercial production extend back for little more than 10 years. About 45,000 trees are now registered, but the greater part of these are not in bearing and many more are dooryard trees not intended for commercial purposes. Large commercial plantings are rare and the industry will not reach its maximum for years to come. All of the different varieties now being planted are more or less in the experimental stage, for no large planting is old enough yet to tell what the trees will do at an advanced age under orchard conditions.

It would be difficult to list all the varieties of the avocado in California, for new types of trees are being continually raised from seed and the first fruits of several such trees are exhibited at practically all of the meetings of the California Avocado Association. The fruit of most of these trees, however, is too poor to be of use, so

[1] The writers are indebted to the California Avocado Association, a cooperative body of avocado growers, and to many individual growers for information and material of great assistance in this investigation.

that the trees are budded over to more promising varieties. At the 1920 spring meeting of the California Avocado Association more than 60 varieties of avocados were on exhibition. In a wise attempt to restrain the commercial plantings of new varieties or strains which have not been thoroughly tested, the association maintains a list of those recommended for commercial use. The varieties now listed are Dickinson, Fuerte, Puebla, Sharpless, and Spinks. Blakeman, Lyon, and Taft, listed in 1919, have been dropped. Descriptions of these varieties can be found in the annual report of the California Avocado Association for 1917 and in the Manual of Tropical and Subtropical Fruits, by Wilson Popenoe.

PURPOSE OF INVESTIGATION.

When it is desirable to harvest fruits or vegetables before they mature, the problem of determining the time of their optimum condition is seldom an easy one. It is particularly difficult in the case of fruits that are raised at a great distance from their markets, in which class belong practically all Pacific coast fruits. Much difficulty has been experienced in trying to place these fruits in eastern markets in a state satisfactory to the consumer, the tendency being to harvest the fruit before it is ready, which results in putting a poor and flavorless product in the hands of the consumer.

While it is true that the avocado has not yet reached the stage of development where it is being shipped to eastern markets in commercial quantities, that time is fast approaching, and even now, under the commercial methods of marketing it in California, knowledge of its composition at maturity is imperative. Avocados are harvested while hard and kept in storage at hotels, clubs, or markets until they have softened. If picked too early the fruit has a tendency to shrivel and become "rubbery," is watery, and lacks the characteristic flavor of well-matured fruit. Its maturity problem thus assumes special importance. Furthermore, this fruit is now in the first period of its development, as far as the American market is concerned. False impressions of its quality created at this time may greatly injure its future. Already some adverse criticism of the avocado, usually traceable to those who have bought immature fruits, is encountered.

The composition of fruit of all of the varieties now grown and of that from seedling trees brought into bearing each year, therefore, is a matter of no little interest to the avocado grower. The work here reported was undertaken for the purpose of throwing some light upon the problems just enumerated.

INVESTIGATIONAL WORK.

METHODS OF SAMPLING.

It has been somewhat difficult to get satisfactory trees from which to obtain samples. Orchards are still too few to afford much choice. For satisfactory data upon which to base opinions of either maturity or average composition, samples of each variety should be secured from each of several districts throughout the State.

Ideal conditions can be secured only where each variety is found growing in the same orchard, thus being exposed to the same climatic conditions and receiving identical cultivation. As some growers neither cultivate nor fertilize their trees, while others do both, it is well within the realm of possibility that the same variety of fruit grown under such varying conditions will differ markedly in composition and maturity. While conditions at the time this work was undertaken were far from ideal, the knowledge gained by any experiment goes far in guiding the industry along the right paths.

A single tree of each of the eight varieties recommended by the California Avocado Association in 1919 [2] was selected, in a location where orchard conditions existed, without regard to climatic conditions. Each location was in a district where the avocado is commercially grown.

The trees were located as follows: The Blakeman at Altadena, the Dickinson at Chula Vista, the Fuerte at Yorba Linda, the Lyon at Whittier, the Puebla at San Fernando, the Sharpless at Tustin, the Spinks at Duarte, and the Taft at Yorba Linda. This list shows a wide distribution of locations, each growing district of California being represented with the exception of Ventura and Santa Barbara Counties.

All of the fruit on the trees, which were young, strong growing specimens, bearing from 25 to 75 fruits, was reserved for samples. Although most of the locations were in secluded areas, a great deal of the fruit was stolen. Loss in one location was caused by wind storms.

Depending on the number of fruits on the tree, samples consisting of from one to six fruits were sent to the laboratory for analysis at monthly intervals. When possible the samples were divided at the laboratory into equal subdivisions, one of which was analyzed at once, the other being wrapped in paper and permitted to soften at room temperature before analysis. Whenever it was necessary to store samples after they were ready for analysis, they were held at a temperature of from 35° to 45° F. The samples analyzed at once are here designated "fresh samples," the others, "storage samples."

[2] Three of these varieties have since been taken from the list because of alleged faults in the trees or fruits. These faults, however, had no bearing on the composition of the fruit.

METHODS OF ANALYSIS.

The methods of analysis of the Association of Official Agricultural Chemists were used.

Specific gravity of the fruit was determined by weighing it in air and under water. Each fruit was then cut in half, lengthwise, the seed removed, and the pulp separated from the skin by means of a spoon. Often it was necessary to remove the skin of the fresh immature samples by paring. In such cases the separations could not always be accurately made, a fact which must be taken into

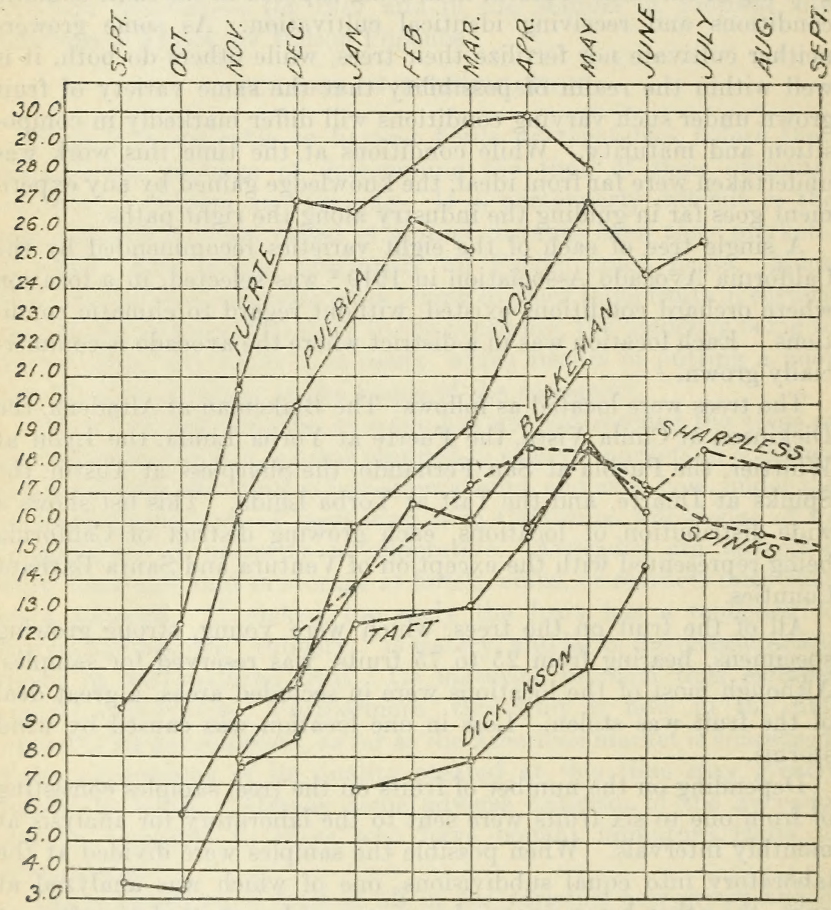

FIGURE 1.—Monthly increase in fat content of the edible portion of avocados.

consideration in interpreting the results. The seed, skin, and pulp were weighed and the percentage of each was determined.

Moisture was determined by drying to constant weight in vacuo at 70° C.

Ash was determined by thoroughly charring the sample at low heat, extracting the char with hot water, and ashing the residue at red heat. Next the water-soluble ash was added. The whole was then evaporated to dryness and heated to very low redness.

Fat was extracted from the moisture-free samples with anhydrous ether in a Soxhlet apparatus.

Sugar was determined after inversion in the cold, by the usual reduction methods, the cuprous oxid being determined by the optional official method, using ferrous sulphate and permanganate solution.

Nitrogen was determined by the Gunning method, the result obtained being multiplied by 6.25 for protein.

Crude fiber was determined by the usual method.

RESULTS OF INVESTIGATION.

The results of this investigation are given in Tables 1 to 6. Table 1 shows the rank of each variety in the matter of weight, percentage of edible portion, seed, and skin, and the percentage of protien, fat, and crude fiber in the edible portion. The data obtained from the analyses of the fruit from the selected trees are presented in Table 2, and, in order to facilitate comparisons, the same data, calculated to a water-free basis, are given in Table 3. Table 4 shows the number of days elapsing between the time the fruits were picked and the time they became soft enough to eat. Table 5 gives the results obtained from the analyses of miscellaneous samples of avocados grown in California. Table 6 gives the results obtained from the analyses of samples of fruit of the varieties introduced from Guatemala and South America by the Office of Seed and Plant Introduction, Bureau of Plant Industry, United States Department of Agriculture. Figure 1 shows the increase in the fat content of the edible portion of the standard varieties of avocados during growth.

TABLE 1.—*Comparison of varieties of the avocado.*

Rank.	Weight.		Seed.		Skin.	
	Variety.	Ounces.	Variety.	Per cent.	Variety.	Per cent.
1	Sharpless	23.4	Fuerte	8.5	Puebla	5.5
2	Spinks	19.3	Sharpless	8.6	Fuerte	5.6
3	Blakeman	18.2	Dickinson	9.5	Blakeman	6.7
4	Lyon	16.7	Lyon	9.7	Spinks	7.0
5	Taft	15.3	Taft	11.8	Sharpless	7.5
6	Fuerte	14.7	Blakeman	14.1	Taft	8.6
7	Dickinson	13.4	Spinks	17.7	Lyon	9.5
8	Puebla	8.3	Puebla	19.4	Dickinson	18.9

Rank.	Edible portion.		Protein in edible portion.		Fat in edible portion.		Crude fiber in edible portion.	
	Variety.	Per cent.	Variety.	Per cent.	Variety.	Per cent.	Variety.	Per cent.
1	Fuerte	85.0	Lyon	4.37	Fuerte	29.93	Taft	0.73
2	Sharpless	84.0	Spinks	2.70	Lyon	26.89	Sharpless	1.09
3	Lyon	78.9	Fuerte	2.32	Puebla	26.45	Spinks	1.09
4	Blakeman	76.4	Puebla	2.30	Blakeman	21.55	Puebla	1.12
5	Puebla	74.0	Blakeman	2.25	Taft	18.89	Lyon	1.15
6	Spinks	73.0	Sharpless	1.92	Spinks	18.53	Dickinson	1.19
7	Taft	72.0	Dickinson	1.66	Sharpless	18.41	Blakeman	1.24
8	Dickinson	68.5	Taft	1.36	Dickinson	14.45	Fuerte	1.35

TABLE 2.—*Composition of avocados at different stages of maturity.*

BLAKEMAN (ALTADENA).

Sample No.	Month picked.	Condition.	Average weight.	Specific gravity.	Edible portion.	Skin.	Seed.	Edible portion.					
								Moisture.	Ash.	Protein.	Fat.	Total sugars.	Crude fiber.
			Ozs.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
42	Nov...	Storage..	10.9	0.9636	73.1	12.6	14.1	84.37	0.87	1.11	7.83	1.76	1.24
69	Feb...	Fresh....	14.3	.9915	76.8	12.9	9.9	75.67	1.38	1.01	13.93	1.69	.....
70	Feb...	Storage..	13.1	.9868	74.4	10.7	14.7	75.77	1.50	1.22	16.56	.82	1.25
81	Mar...	...do.....	16.5	1.0085	74.6	9.4	15.7	76.16	1.22	1.03	16.04	.70	1.25
107	May...	...do.....	18.2	1.0188	76.4	6.7	16.9	69.14	1.61	2.25	21.55	.49	1.53
DICKINSON (CHULA VISTA).													
59	Jan...	Fresh....	11.6	1.0173	65.3	22.8	11.2	84.84	0.90	0.79	4.17	3.50	.....
60	Jan...	Storage..	10.6	.9428	68.4	21.9	9.5	86.47	1.20	1.01	6.84	.37	.....
71	Feb...	Fresh....	11.2	1.0159	65.0	24.5	10.2	84.23	.94	.79	5.87	2.80	.....
72	Feb...	Storage..	9.7	.9753	67.6	19.7	13.0	86.10	1.02	.94	7.20	.55	1.34
83	Mar...	Fresh....	11.4	1.0160	62.0	25.1	12.3	83.95	1.03	.94	6.15	2.52	.....
84	Mar...	Storage..	10.2	.9540	66.7	20.6	12.7	85.40	1.19	1.31	7.80	.58	1.30
95	Apr...	Fresh....	11.6	1.0063	62.0	23.3	14.3	84.56	1.23	1.37	7.63	.67	.....
96	Apr...	Storage..	10.5	.9650	65.8	20.8	13.1	84.71	1.12	1.31	9.68	.36	1.19
100	May...	...do.....	10.9	1.0031	68.3	18.2	13.3	82.74	1.32	1.66	9.84	.41	1.30
110	May...	...do.....	13.4	.9858	68.5	18.9	12.7	81.03	1.28	1.40	10.96	.46	1.26
120	June..	Fresh....	16.0	.9892	70.2	18.8	10.9	75.41	1.41	1.90	14.06	1.16	.....
121	June..	Storage..	11.2	.9770	60.1	21.4	18.5	75.82	1.56	1.66	14.45	.57	1.68
FUERTE (YORBA LINDA).													
23	Sept...	Fresh....	8.9	0.9958	73.4	11.0	14.6	81.69	0.72	1.50	6.97	3.06	1.27
24	Sept...	Storage..	5.7	.9969	76.9	9.5	13.0	82.33	.80	1.66	9.61	.69	1.48
31	Oct...	Fresh....	11.5	.9921	77.6	8.3	13.5	78.35	.76	1.44	11.32	2.12	1.35
32	Oct...	Storage..	10.1	1.0099	77.8	6.2	15.4	78.97	.91	1.75	12.46	1.02	1.50
46	Nov...	Fresh....	11.2	.9864	78.0	7.7	13.8	72.72	1.02	1.55	17.61	1.08	1.32
47	Nov...	Storage..	10.2	1.0075	76.4	6.4	16.7	70.93	1.24	1.88	20.57	.71	1.62
52	Dec...	Fresh....	12.2	.9764	77.1	8.3	14.1	67.42	1.17	1.71	23.99	.58	1.47
53	Dec...	Storage..	10.0	.9810	80.5	6.8	12.5	64.18	1.69	1.99	26.99	.57	1.64
62	Jan...	Fresh....	13.9	.9728	76.5	7.7	15.2	65.99	1.24	1.49	25.12	.38	1.33
63	Jan...	Storage..	12.6	.9967	79.4	6.3	13.9	65.31	1.25	1.49	26.62	.29	1.44
76	Mar...	Fresh....	16.7	.9616	79.9	7.7	11.9	63.93	1.34	1.73	26.13	.17	1.08
77	Mar...	Storage..	14.7	.9861	81.6	5.6	12.7	62.08	1.43	1.68	29.74	.39	1.36
88	Apr...	Fresh....	13.9	.9596	79.2	9.1	11.2	63.46	1.40	1.88	28.19	.11	1.25
89	Apr...	Storage..	13.1	.9626	82.6	7.5	9.7	62.07	1.42	2.10	29.93	.31	1.42
97	May...	Fresh....	11.4	.9688	78.9	10.9	9.7	61.08	1.33	2.32	30.15	.13	1.24
98	May...	Storage..	11.4	.9616	85.0	6.0	8.5	63.94	1.41	2.32	28.06	.28	1.35
LYON (WHITTIER).													
27	Oct...	Fresh....	5.5	0.9954	61.9	19.1	18.4	85.87	0.61	1.71	4.26	2.59	.....
28	Oct...	Storage..	4.8	.9790	65.5	15.6	18.6	85.45	.87	2.10	5.90	1.56	1.15
38	Nov...	Fresh....	11.2	.9968	65.4	16.1	17.5	82.48	.73	1.36	6.55	3.31	.....
39	Nov...	Storage..	9.1	.9144	66.7	13.8	19.4	83.13	.81	1.71	9.52	1.81	1.20
54	Dec...	Fresh....	12.4	.9902	66.6	15.8	17.1	81.49	.68	1.27	7.63	3.28	.....
55	Dec...	Storage..	9.8	.9292	69.0	12.9	18.0	80.59	.93	1.49	10.42	2.24	1.16
65	Jan...	Fresh....	12.5	1.0052	68.0	18.2	13.5	73.20	.96	1.93	14.01	2.92	.....
66	Jan...	Storage..	10.3	.9317	63.6	13.0	23.2	74.83	1.06	2.25	15.76	1.51	1.35
79	Mar...	Fresh....	14.3	.9990	68.6	15.3	15.8	69.85	1.09	2.34	16.66	1.67	.....
80	Mar...	Storage..	13.4	.9892	68.6	11.7	19.4	70.66	1.17	2.45	19.29	1.90	1.19
90	Apr...	Fresh....	16.5	.9833	70.9	14.8	14.1	66.79	1.19	2.60	21.34	1.29	.....
91	Apr...	Storage..	13.2	.9798	70.5	10.8	18.6	66.13	1.24	3.02	23.41	1.65	1.25
105	May...	Fresh....	14.8	.9849	72.5	14.6	12.4	62.95	1.19	3.41	25.07	.80	.....
106	May...	Storage..	10.6	.9719	78.9	11.4	9.7	61.56	1.43	4.37	26.89	.94	1.29
116	June..	Fresh....	15.9	.9827	77.1	11.5	11.0	64.44	1.33	2.66	22.91	1.07	.....
117	June..	Storage..	15.3	1.0051	76.9	9.5	13.0	64.58	1.29	3.28	24.43	.37	1.22
122	July...	...do.....	16.7	.9656	77.8	11.1	11.0	68.52	1.17	3.02	25.57	.53	1.15

TABLE 2.—*Composition of avocados at different stages of maturity*—Continued.

PUEBLA (SAN FERNANDO).

Sample No.	Month picked.	Condition.	Average weight.	Specific gravity.	Edible portion.	Skin.	Seed.	Edible portion.					
								Moisture.	Ash.	Protein.	Fat.	Total sugars.	Crude fiber.
			Ozs.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
36	Oct...	Fresh....	6.9	1.0107	64.9	10.3	24.4	82.88	0.83	1.77	6.72	2.31	.....
37	Oct...	Storage..	5.7	1.0324	67.5	6.1	25.6	80.12	1.10	2.30	8.87	2.58	1.35
40	Nov...	Fresh....	7.2	1.0147	67.7	8.4	23.6	76.29	1.09	1.62	13.12	1.64	.....
41	Nov...	Storage..	6.9	1.0324	67.6	5.8	26.4	73.49	1.34	2.08	16.36	1.45	1.43
48	Dec...	Fresh....	7.6	1.0022	72.7	7.9	19.0	73.50	1.17	1.62	15.59	1.74	.....
49	Dec...	Storage..	6.6	1.0282	71.4	5.5	22.8	70.01	1.60	2.02	19.99	1.47	1.40
68	Feb...	...do.....	6.5	1.0225	68.1	8.1	23.3	63.59	1.72	2.19	26.45	.88	1.42
82	Mar...	...do.....	8.3	1.0232	74.0	6.2	19.4	64.89	1.77	2.27	25.33	.75	1.12
					SHARPLESS (TUSTIN).								
92	Apr...	Fresh....	18.5	0.9906	75.2	13.7	10.4	77.11	1.13	1.07	14.73	1.54	.....
93	Apr...	Storage..	18.2	.9312	77.9	10.6	11.7	77.34	1.23	1.37	15.68	.58	1.13
101	May...	Fresh....	16.4	.9884	72.1	15.1	12.5	76.11	1.17	1.13	16.05	.88	.....
102	May...	Storage..	11.7	.9501	75.1	12.8	12.0	74.57	1.38	1.27	18.41	.60	1.14
112	June..	Fresh....	18.8	.9811	75.3	13.2	11.2	76.99	1.29	1.33	15.79	.41	.....
113	June..	Storage..	23.0	.9255	81.9	7.9	10.2	75.83	1.46	1.31	16.91	.40	1.12
124	July...	...do.....	22.4	.9781	80.0	9.2	10.6	74.65	1.50	1.44	18.39	.27	1.09
127	Aug...	Fresh....	26.6	.9812	78.2	11.7	10.0	73.33	1.42	1.78	18.47	.34	.....
128	Aug...	Storage..	23.4	.9908	84.0	7.5	8.6	73.97	1.58	1.92	17.88	.25	1.12
130	Sept..	...do.....	22.9	.9762	82.8	7.6	9.2	74.94	1.51	1.36	17.71	.36	1.20
					SPINKS (DUARTE).								
56	Dec...	Fresh....	14.5	0.9718	60.8	12.8	25.9	78.55	1.13	1.40	11.03	2.16	.....
57	Dec...	Storage..	13.0	.9460	64.8	11.8	23.3	77.62	1.52	1.77	12.22	1.06	1.27
74	Mar...	Fresh....	15.8	.9853	64.1	12.2	23.3	76.15	1.19	1.53	14.36	1.52	.....
75	Mar...	Storage..	12.6	.9950	69.8	10.6	19.1	73.04	1.42	1.84	17.23	.93	1.28
85	Apr...	Fresh....	17.5	.9527	65.2	13.5	20.7	72.56	1.43	2.36	18.13	.58	.....
86	Apr...	Storage..	18.8	1.0001	69.5	8.5	21.8	72.66	1.44	2.32	18.53	.59	1.09
108	May ..	Fresh....	21.0	.9450	68.5	9.4	21.7	73.74	1.40	2.40	16.96	.17	.....
109	May ..	Storage..	19.3	.9977	73.0	7.0	19.2	72.85	1.54	2.36	18.37	.53	1.11
118	June..	Fresh....	16.9	.9403	69.1	11.2	19.3	74.15	1.24	1.79	17.03	.42	.....
119	June..	Storage..	13.1	1.0038	71.0	11.2	17.7	73.47	1.42	1.92	17.21	.62	1.37
125	July ..	...do.....	17.5	1.0147	64.0	7.0	29.0	75.66	1.42	1.66	16.04	.40	.....
126	Aug...	...do.....	15.3	1.0152	69.5	8.9	21.4	75.27	1.53	2.70	15.54	.62	1.20
129	Sept..	...do.....	18.8	.9830	71.8	8.1	20.2	75.66	1.60	2.62	15.14	.40	1.09
					TAFT (YORBA LINDA).								
25	Sept..	Fresh....	4.8	0.9870	64.7	10.7	23.9	87.97	0.58	1.23	2.20	3.60	.....
26	Sept..	Storage..	3.8	.9869	71.5	8.6	19.8	88.67	.79	1.36	3.51	1.58	1.00
34	Oct...	Fresh....	7.4	1.0044	71.3	16.5	11.4	87.57	.59	.96	2.39	3.50	.....
35	Oct...	Storage..	4.9	.9460	71.8	16.4	11.8	88.67	.67	1.16	3.34	2.04	.73
44	Nov...	Fresh....	9.8	1.0001	70.6	17.0	11.6	84.34	.72	.66	6.45	2.93	.....
45	Nov...	Storage..	8.5	.9443	67.3	16.7	15.8	84.46	.85	.83	7.56	1.71	.99
50	Dec...	Fresh....	7.9	1.0020	68.9	17.0	13.3	83.58	.78	.52	6.88	2.51	.....
51	Dec...	Storage..	8.3	.9749	70.8	13.8	15.3	83.86	1.13	.79	8.60	1.28	.93
61	Jan...	...do.....	8.2	.9324	70.1	16.2	13.7	80.04	1.24	1.03	12.46	.71	.97
78	Mar...	...do.....	14.4	.9927	72.0	11.7	16.3	78.87	1.11	.79	13.12	.68	.91
87	Apr...	...do.....	14.2	.9833	70.1	12.2	17.2	76.52	1.35	1.40	15.51	.71	.95
103	May ..	Fresh....	15.8	.9811	69.8	15.1	14.6	72.01	1.60	1.53	19.48	.71	.....
104	May ..	Storage..	15.3	1.0025	71.6	10.8	17.4	73.75	1.45	1.31	18.89	.58	1.03
114	June..	Fresh....	16.4	.9981	66.4	14.5	18.9	71.56	1.47	1.22	20.27	.44	.....
115	June..	Storage..	10.8	1.0141	70.4	11.1	18.7	76.19	1.51	1.31	16.34	.68	.97

TABLE 3.—*Composition of avocados at different stages of maturity (calculated to water-free basis).*

Sample No.	Month picked.	Condition.	Ash.	Protein.	Fat.	Total sugars.	Crude fiber.	Undetermined.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
BLAKEMAN (ALTADENA).								
42	Nov.	Storage	5.57	7.10	50.09	11.26	7.89	18.04
69	Feb.	Fresh	5.67	4.15	57.25	6.95	.....	.....
70	Feb.	Storage	6.19	5.03	68.35	3.38	5.15	11.89
81	Mar.	do	5.12	4.32	67.28	2.94	5.24	15.10
107	May.	do	5.22	7.29	69.83	1.59	4.96	11.11
DICKINSON (CHULA VISTA).								
59	Jan.	Fresh	5.93	5.21	27.49	23.07	.....	.....
60	Jan.	Storage	8.87	7.46	50.55	2.73	.....	.....
71	Feb.	Fresh	5.96	5.01	37.24	17.75	.....	.....
72	Feb.	Storage	7.37	6.76	51.79	3.96	9.64	20.50
83	Mar.	Fresh	6.42	5.86	38.33	15.70	.....	.....
84	Mar.	Storage	8.15	8.97	53.42	3.97	8.90	16.58
95	Apr.	Fresh	7.97	8.87	49.43	4.34	.....	.....
96	Apr.	Storage	7.32	8.57	63.33	2.35	7.78	10.66
100	May.	do	7.65	9.62	57.00	2.38	7.53	15.82
110	May.	do	6.75	7.38	57.77	2.42	6.64	19.03
120	June.	Fresh	5.73	7.73	57.18	4.72	.....	.....
121	June.	Storage	6.45	6.86	59.76	2.36	6.95	17.62
FUERTE (YORBA LINDA).								
23	Sept.	Fresh	3.93	8.19	38.06	16.71	6.94	26.16
24	Sept.	Storage	4.53	9.39	54.38	3.90	8.38	19.41
31	Oct.	Fresh	3.51	6.65	52.28	9.79	6.24	21.52
32	Oct.	Storage	4.33	8.32	59.25	4.85	7.13	16.12
46	Nov.	Fresh	3.74	5.68	64.55	3.96	4.84	17.23
47	Nov.	Storage	4.27	6.47	70.76	2.44	5.57	10.49
52	Dec.	Fresh	3.59	5.25	73.64	1.78	4.51	11.23
53	Dec.	Storage	4.72	5.56	75.35	1.59	4.58	8.21
62	Jan.	Fresh	3.65	4.38	73.86	1.12	3.91	13.08
63	Jan.	Storage	3.60	4.29	76.73	.84	4.15	10.38
76	Mar.	Fresh	3.72	4.80	72.45	.47	2.99	15.58
77	Mar.	Storage	3.77	4.43	78.43	1.03	3.59	8.76
88	Apr.	Fresh	3.83	5.15	77.15	.30	3.42	10.15
89	Apr.	Storage	3.74	5.54	78.91	.82	3.74	7.25
97	May.	Fresh	3.42	5.96	77.47	.33	3.19	9.64
98	May.	Storage	3.91	6.43	77.82	.78	3.74	7.32
LYON (WHITTIER).								
27	Oct.	Fresh	4.32	12.10	30.15	18.33	.....	.....
28	Oct.	Storage	5.98	14.43	40.55	10.72	7.90	20.41
38	Nov.	Fresh	4.17	7.76	37.38	18.89	.....	.....
39	Nov.	Storage	4.80	10.14	56.43	10.73	7.11	10.79
54	Dec.	Fresh	3.67	6.86	41.24	17.72	.....	.....
55	Dec.	Storage	4.79	7.68	53.69	11.54	5.98	16.33
65	Jan.	Fresh	3.58	7.20	52.27	10.89	.....	.....
66	Jan.	Storage	4.21	8.94	62.61	6.00	5.36	12.87
79	Mar.	Fresh	3.62	7.76	55.26	5.54	.....	.....
80	Mar.	Storage	3.99	8.35	65.75	6.48	4.06	11.38
90	Apr.	Fresh	3.58	7.83	64.26	3.88	.....	.....
91	Apr.	Storage	3.66	8.92	69.12	4.87	3.69	9.74
105	May.	Fresh	3.21	9.20	67.67	2.16	.....	.....
106	May.	Storage	3.72	11.37	69.96	2.45	3.36	9.16
116	June.	Fresh	3.74	7.48	64.43	3.01	.....	.....
117	June.	Storage	3.64	9.26	68.97	1.04	3.44	13.64
122	July.	do	3.72	9.59	81.22	1.68	3.65	.13
PUEBLA (SAN FERNANDO).								
36	Oct.	Fresh	4.85	10.34	39.25	13.49	.....	.....
37	Oct.	Storage	5.53	11.57	44.62	12.98	6.79	18.51
40	Nov.	Fresh	4.60	6.83	55.33	6.92	.....	.....
41	Nov.	Storage	5.05	7.85	61.71	5.47	5.39	14.52
48	Dec.	Fresh	4.41	6.11	58.83	6.57	.....	.....
49	Dec.	Storage	5.33	6.74	66.65	4.90	4.67	11.70
68	Feb.	do	4.72	6.02	72.65	2.42	3.90	10.30
82	Mar.	do	5.04	6.47	72.14	2.14	3.19	11.02

TABLE 3.—*Composition of avocados at different stages of maturity (calculated to water-free basis)*—Continued.

SHARPLESS (TUSTIN).

Sample No.	Month picked.	Condition.	Ash.	Protein.	Fat.	Total sugars.	Crude fiber.	Undetermined.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
92	Apr.	Fresh	4.94	4.67	64.35	6.73	.....	.....
93	Apr.	Storage	5.43	6.05	69.19	2.56	4.99	11.77
101	May	Fresh	4.90	4.73	67.18	3.68	.....	.....
102	May	Storage	5.43	4.99	72.40	2.36	4.48	10.34
112	June	Fresh	5.61	5.78	68.62	1.78	.....	.....
113	June	Storage	6.04	5.42	69.97	1.65	4.63	12.29
124	July	do	5.92	5.68	72.55	1.07	4.30	10.49
127	Aug.	Fresh	5.32	6.17	69.25	1.27	.....	.....
128	Aug.	Storage	6.07	7.38	68.69	.96	4.30	12.60
130	Sept.	do	6.02	5.43	70.67	1.44	4.79	11.65

SPINKS (DUARTE).

56	Dec.	Fresh	5.27	6.53	51.42	10.07	.....	.....
57	Dec.	Storage	6.79	7.91	54.60	4.74	5.67	20.28
74	Mar.	Fresh	4.99	6.41	60.21	6.37	.....	.....
75	Mar.	Storage	5.27	6.82	63.91	3.45	4.75	15.80
85	Apr.	Fresh	5.21	8.60	66.07	2.11	.....	.....
86	Apr.	Storage	5.27	8.49	67.78	2.16	3.99	12.33
108	May	Fresh	5.33	9.14	64.59	.65	.....	.....
109	May	Storage	5.67	8.69	67.66	1.95	4.09	11.93
118	June	Fresh	4.80	6.92	65.88	1.62	.....	.....
119	June	Storage	5.35	7.24	64.87	2.34	5.16	15.04
125	July	do	5.83	6.82	65.90	1.64	.....	.....
126	Aug.	do	6.19	10.92	62.84	2.51	4.85	12.70
129	Sept.	do	6.57	10.76	62.20	1.64	4.48	14.34

TAFT (YORBA LINDA).

25	Sept.	Fresh	4.82	10.22	18.29	29.92	.....	.....
26	Sept.	Storage	6.97	12.00	30.98	13.95	8.82	27.27
34	Oct.	Fresh	4.75	7.72	19.23	28.16	.....	.....
35	Oct.	Storage	5.91	10.24	24.98	18.00	6.44	29.92
44	Nov.	Fresh	4.69	4.21	41.17	18.71	.....	.....
45	Nov.	Storage	5.47	5.34	48.65	11.00	6.37	23.16
50	Dec.	Fresh	4.75	3.17	41.90	15.28	.....	.....
51	Dec.	Storage	7.00	4.89	53.28	7.93	5.76	21.13
61	Jan.	do	6.21	5.16	62.42	3.56	4.86	17.79
78	Mar.	do	5.25	3.74	62.09	3.22	4.31	21.39
87	Apr.	do	5.75	5.96	66.10	3.02	4.05	15.16
103	May	Fresh	5.72	5.47	69.59	2.54	.....	.....
104	May	Storage	5.52	4.99	71.97	2.21	3.92	11.39
114	June	Fresh	5.17	4.29	71.27	1.55	.....	.....
115	June	Storage	6.34	5.50	68.63	2.86	4.07	12.60

TABLE 4.—*Number of days required for softening avocados.*

Variety.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Spinks	.....	.....	.....	.....	9	.....	7	6	6	2	2	6	6
Fuerte	13	11	.....	12	16	6	7	5	6	.....	.....	.....	.....
Taft	14	12	.....	13	16	19	6	5	7	5	.....	.....	.....
Puebla	.....	12	.....	14	13	12	10	.....	.....	.....	.....	.....	.....
Lyon	.....	12-15	22	.....	17	19	8	5	6	4	2	.....	.....
Sharpless	.....	.....	.....	.....	.....	.....	.....	10	7	5	2	6	10
Dickinson	.....	.....	.....	.....	22	17	20	9	9-10	3	.....	.....	.....
Blakeman	.....	.....	.....	14	.....	9	6	.....	9	.....	.....	.....	.....

TABLE 5.—*Composition of miscellaneous samples of California avocados.*

Sample No.	Variety.	Location.	Date.		Outside color.		Average weight per fruit.	Specific gravity.	Seed.	Pulp.	Skin.	Edible portion.						Remarks.
			Picked.	Softened.	Fresh.	Storage.						Moisture.	Ash.	Protein.	Fat.	Total sugars.	Crude fiber.	
							Ounces		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
1	Fuerte	Yorba Linda	1917. Mar. 2	1917. Mar. 20		Green	6.3	1.0240	19.9	70.1	9.8	65.71	1.23	1.91	25.75	0.58	.....	Mature.
2	Small round Fuerte.	do	do	Mar. 22		Green, dark spots.	5.8	1.0077	15.7	74.4	9.1	62.94	1.32	1.98	28.11	.67	1.93	Do.
5	Fuerte	do	Mar. 17	Apr. 5		Dark green	8.6	1.0109	18.2	74.4	7.0	67.21	1.59	1.92	24.25	.80	1.47	Do.
10	do	Altadena	July 13	July 20		Partly purple.	10.27	.9790	11.6	81.9	5.2	63.57	1.67	2.27	27.64	.27	2.14	Do.
15	do	do	July 15	do		Dark green dark purple.	7.41	.9722	10.2	80.7	7.6	62.52	1.64	2.22	28.95	.37	1.72	Slightly overmature.
18	do	do	July 25	Aug. 13		Green and black.	9.91	.....	14.9	74.9	9.3	63.45	1.71	2.22	27.63	.49	1.61	Overmature.
33	Seedless Fuerte.	Yorba Linda	1919. Oct. 16	1919. Oct. 29		Green	.85	1.0104	.....	88.4	10.2	78.51	1.04	2.36	10.62	1.43	.....	Immature.
64	do	do	1920. Jan. 30	1920. Feb. 14		do	.88	1.0028	.....	85.32	13.9	64.56	1.37	1.71	24.92	.59	.....	Mature.
3	Sharpless	Santa Ana	1917. Mar. 2	1917. Mar. 22		Blackish purple.	17.7	.9810	14.6	73.2	7.6	73.76	1.16	1.83	16.90	.74	1.37	Maturity doubtful.
4	Lambert	Hollywood	Mar. 13	Apr. 5		Green, dark spots.	10.2	1.0270	22.9	68.0	8.8	74.59	1.26	2.47	15.21	1.33	1.79	Do.
6	Monroe	Santa Ana	Mar. 29	do		do	13.9	.9256	26.2	62.1	11.6	74.95	1.11	2.04	15.89	.90	1.63	.....
7	Lyon	La Habra	Apr. 10			do	15.2	.9560	19.3	69.0	11.4	77.25	.97	2.11	13.36	1.99	1.22	Maturity doubtful.
29	do	Whittier	1919. Oct. 3	1919. Oct. 18		do	7.7	.9135	14.7	71.2	13.8	84.92	.94	2.78	6.61	1.11	.....	Very immature.
8	Surprise	Hollywood	1917. Apr. 11			do	16.7	.9996	22.2	70.1	7.7	81.29	1.15	2.38	10.07	1.50	1.29	Maturity doubtful.
9	Dickey A	Nordhoff	May 21	June 7		Dark purple—black.	17.1	1.0239	19.1	72.4	8.1	73.79	1.26	2.32	11.60	.31	1.65	.....

30	.....do.....	Whittier....	1919. Oct. 3	1919. Oct. 14	.....	Green, one-third purple.	7.6	.9895	8.1	78.6	13.3	85.44	.65	1.75	6.37	1.56	1.11	Very immature.
11	Challenge.....	Los Angeles.	1917. July 13	1917. July 31	.....	Black.....	19.9	1.0074	20.2	74.0	5.4	81.39	1.09	3.18	10.90	.62	.85	Maturity doubtful.
12	Spinks.....	Duarte.....	July 17	July 25	.....	Dark purple—black.	14.4	1.0066	18.1	73.5	8.4	76.23	1.43	2.29	16.43	.44	1.38	Mature.
13	Caribou.....	.....do.....	...do.....	Aug. 13	.....	Black.....	12.3	1.0369	24.6	65.5	9.7	75.81	1.75	2.92	13.44	.71	2.02	Immature.
14	I. X. L.....	.....do.....	...do.....	July 25	.....	Green and purple.	25.9	.9782	11.8	76.3	11.6	78.92	1.54	2.81	12.55	.41	1.66	Probably mature.
181	Knight.....	.....do.....	1921. June 30	1921.	Green.....	.....	16.86	.9558	17.22	70.60	12.12	77.18	.....	2.54	14.88	.....	.....	Mature.
182	.....do.....	.....do.....	...do.....	July 9	.....do.....	Green.....	16.94	.9742	17.93	68.38	13.42	77.20	.....	2.28	15.06	.....	.....	Do.
183	Spinks seedling No. 1.	.....do.....	...do.....	.....	.....do.....	.....	21.49	.9895	16.25	61.39	22.01	73.74	.....	1.71	17.46	.....	.....	Do.
184	.....do.....	.....do.....	...do.....	July 9	.....do.....	Green, one-third brown.	17.53	.9814	16.22	70.27	13.21	79.70	.....	1.71	12.76	.....	.....	Do.
185	Spinks seedling No. 2.	.....do.....	...do.....	.....	.....do.....	.....	19.16	.9698	15.84	71.06	13.18	80.66	.....	1.20	13.14	.....	.....	Do.
186	.....do.....	.....do.....	...do.....	July 9	.....do.....	Green, part brown.	18.46	.9679	14.64	74.71	10.36	80.04	.....	1.54	14.10	.....	.....	Do.
187	Spinks seedling No. 3.	.....do.....	...do.....	.....	.....do.....	.....	18.49	.9733	17.27	73.34	9.20	68.25	.....	2.38	23.31	.....	.....	Do.
188	.....do.....	.....do.....	...do.....	July 9	.....do.....	One-half green, one-half brown.	13.57	.9942	14.87	75.95	9.11	68.98	.....	1.88	22.70	.....	.....	Do.
189	Alexandria seedling.	.....do.....	...do.....	.....	.....do.....	.....	27.67	.9466	10.72	80.53	8.69	78.06	.....	1.88	16.68	.....	.....	Do.
190	.....do.....	.....do.....	...do.....	July 9	Bright green.	Green.....	22.19	.9906	10.99	81.19	7.75	79.13	.....	1.49	15.14	.....	.....	Do.
16	Blakeman.....	Hollywood..	1917. July 24	1917. Aug. 20	.....	Dark green, black spots.	9.4	1.0389	16.5	76.0	7.6	74.24	1.52	3.19	15.25	.64	1.90	.....
17	Murietta seedling, Buttercup.	.....	...do.....	July 31	.....	Green.....	12.3	1.0280	24.2	62.5	12.9	75.58	1.24	1.93	14.91	.27	1.45	.....
19	Taft.....	Orange.....	July 30	July 30	.....	Dark green, black spots.	14.3	.....	21.2	69.4	9.2	70.42	1.59	3.14	19.87	.49	1.40	Overmature.
22	Linda.....	Yorba Linda	1919. Aug. 22	1919. Aug. 22	.....	Dark purple.	27.6	.9937	15.8	72.4	11.3	78.86	1.31	1.81	13.36	.72	1.30	Mature.
58	Guatemalan seedling.	Sierra Madre	Jan. 6	Jan. 15	.....	Brownish-purple.	15.2	.9548	19.2	65.98	14.7	65.93	1.89	1.73	24.89	1.00	1.42	Overmature.
67	Mexican No. 5..	Whittier....	1920. Jan. 30	1920. Feb. 16	.....	Green.....	16.5	.9288	9.5	80.22	10.7	80.38	1.08	1.97	11.51	.67	1.23	Maturity doubtful.

TABLE 5.—*Composition of miscellaneous samples of California avocados*—Continued.

Sample No.	Variety.	Location.	Date.		Outside color.		Average weight per fruit.	Specific gravity.	Seed.	Pulp.	Skin.	Edible portion.						Remarks.
			Picked.	Softened.	Fresh.	Storage.						Moisture.	Ash.	Protein.	Fat.	Total sugars.	Crude fiber.	
			1920.	1920.			*Ounces*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
73	Dutton seedling.	Anaheim	Feb. 21	Mar. 8	.....	Purple	9.2	1.0202	22.6	68.57	8.9	81.24	1.06	2.36	14.09	0.66	1.27	.....
131	Oakley No. 1	Santa Monica.	Sept. 23	.....	Slight green, purple.	.....	19.6	.9743	17.5	72.96	9.2	70.78	1.21	3.01	16.92	.40	.....	Maturity doubtful.
132	do	do	do	Oct. 3	do	Purple	17.2	1.0157	17.2	76.59	6.1	69.45	1.30	3.81	19.44	.78	1.57	Do.
133	Oakley No. 2	do	do	.....	Green	.....	16.8	.9523	19.2	72.29	8.1	78.24	.83	1.94	12.07	2.04	.....	Do.
134	do	do	do	Oct. 3	do	Green, dark spot.	16.3	.9607	14.9	79.21	5.8	78.01	.96	2.67	13.63	.80	1.11	Do.
135	Oakley No. 3	do	do	Oct. 8	Purple	Blackish purple.	15.9	.9865	10.1	83.57	6.2	71.13	1.41	3.54	18.23	.59	.....	Mature.
136	Oakley No. 4	do	do	Oct. 4	do	do	10.4	1.0083	15.8	77.16	6.9	65.76	1.58	3.67	22.64	.50	1.54	Do.
94	Anna Campbell seedling.	Hollywood	Apr. 18	Apr. 20	Dark purple	Dark purple	10.8	.9701	18.9	69.62	11.3	72.22	1.27	2.75	19.26	.85	1.01	Do.
142	Hoff seedling	do	Nov. 2	Nov. 15	Olive green	Olive green	13.6	1.0013	17.5	76.17	6.3	71.13	1.51	2.23	18.47	.....	1.34	Do.
			1921.	1921.														
161	America seedling.	do	June 21	June 22	.....	Purple	22.8	.9272	6.7	86.62	6.3	81.34	.....	2.20	11.31	.87	.....	Overmature.
300	Harvey Spencer seedling.	do	Aug. 8	Aug. 15	Black	Black	12.0	1.0089	21.7	69.25	8.8	74.01	.....	1.96	16.59	.....	.....	Mature.
160	Dehcious seedling.	Pasadena	June 10	June 22	Purple	Purple	9.1	.9728	20.6	64.84	13.3	71.69	.....	2.36	19.79	.85	.....	Do.
163	Gage seedling	Fullerton	June 27	July 5	Bright green.	Green, slight brown.	16.2	.9882	22.5	66.34	11.1	62.94	.....	2.98	25.23	.....	.....	Do.
202	Quaker seedling.	Whittier	Sept. 24	Oct. 3	Green	Dark green	16.5	.....	10.1	81.14	8.3	72.92	.....	1.90	19.53	.....	.....	Do.

TABLE 6.—*Composition of varieties of avocado introduced by Office of Seed and Plant Introduction, Bureau of Plant Industry.*

Sample No.	Variety.[1]	S. P. I. No.	Date.		Outside color.		Average weight per fruit.	Specific gravity.	Seed.	Pulp.	Skin.	Edible portion.						Remarks.
			Picked.	Softened.	Fresh.	Storage.						Moisture.	Ash.	Protein.	Fat.	Total sugars.	Crude fiber.	
			1921.	1921.			*Ounces*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
146	Pankay	44785	May 5	May 9		Green	10.73	0.9202	15.86	62.15	21.98	69.53	1.42	1.24	20.38	0.81	1.68	Mature.
147	do		do		Green		10.93	1.0058	14.03	59.07	26.64	76.98	1.26	1.11		1.55		Do.
175	do		June 30		Bright green		8.79	1.0152	20.16	52.50	26.85	71.34		1.44	16.35			Do.
176	do		do	July 9	do	Green, one-half dark brown.	10.95	.9944	13.14	64.50	22.12	71.06		1.64	18.59			Do.
148	Benik	44626	May 5	May 13	Purple-green.	Purple—brown.	13.53	.9948	13.49	70.56	15.82	70.64	0.64	1.52	21.10	.80	1.17	Do.
177	do		June 30		do		14.70	.9906	14.32	68.50	16.95	68.49		1.54	22.47			Do.
178	do		do	July 8	do	Purple	15.50	1.0057	14.04	72.82	13.18	68.34		1.60	23.16			Do.
150	Mayapan	44680	May 5		Green—slight purple.		12.12	.9980	14.47	65.12	20.26	75.30	1.30	1.40	14.46	1.44		Do.
149	do		do	May 12	do	Dark purple, slight green.	9.69	.9770	10.51	69.20	19.93	75.60	1.18	1.09	16.66	.40	1.49	Do.
173	do		June 30		do		11.25	.9954	12.00	67.81	19.88	73.58		1.22	17.45			Do.
174	do		do	July 11	do	Purple, green spots.	12.77	1.0000	12.50	68.96	18.34	72.78		1.62	18.11			Do.
151	Cantel	44783	May 5		Green		11.77	.9773	10.58	69.75	19.22	78.14	.98	1.22	12.12	2.74		Immature.
152	do		do	May 28	do	Green	11.82	.9175	10.10	75.14	14.76	77.19	1.26	1.75	14.34	.27	1.38	Do.
168	do		June 30		do		10.47	.9704	10.39	65.25	19.42	73.28		1.31	17.82			Mature.
169	do		do	July 11	do	Green	11.40	.9518	11.26	72.62	15.85	74.18		1.22	17.34			Do.
153	Nimlioh	44440	May 5		do		24.36	.9744	17.94	67.56	14.26	79.47	.89	.94	11.15	3.10		Immature.
154	do		do	May 21	do	Green	16.53	.9702	16.14	70.32	13.48	82.68	1.06	1.71	11.13	.70	1.05	Do.
164	do		June 30		Bright green, dark spots.		23.90	.9701	11.82	72.40	15.05	76.06		.83	15.84			Mature.
165	do		do	July 8	do	Green	20.91	.9723	15.17	71.81	12.92	78.80		1.05	13.88			Do.
156	Lamat	43476	May 5		Bright green.		12.28	.9823	10.23	68.20	21.06	78.27	1.15	.93	13.25	1.49		Do.
155	do		do	May 7	do	Green, dark spots.	11.88	.9107	14.92	67.36	17.78	79.61	1.22	1.12	12.84	.27	1.40	Do.
166	do		June 30		do		10.60	.9902	8.68	71.19	19.87	73.43		1.44	18.38			Do.
167	do		do	July 11	do	Green	12.30	.9538	11.27	71.39	17.26	78.24		1.27	14.02			Do.

TABLE 6.—*Composition of varieties of avocado introduced by Office of Seed and Plant Introduction, Bureau of Plant Industry*—Continued.

Sample No.	Variety.[1]	S. P. I. No.	Date.		Outside color.		Average weight per fruit.	Specific gravity.	Edible portion.								Remarks.
			Picked.	Softened.	Fresh.	Storage.			Seed.	Pulp.	Skin.	Moisture.	Ash.	Protein.	Fat.	Total sugars.	Crude fiber.	
			1921.	1921.			*Ounces.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
158	Cabnal	44782	May 5		Slight purple, dark green.		14.69	0.9790	12.43	68.70	18.87	70.49	1.29	1.42	21.98	0.56	.....	Mature.
157	....do		....do	May 5	.....do	Green, dark spots.	16.79	.9806	13.54	65.94	19.85	70.19	1.36	1.70	20.89	.53	1.22	Do.
179	Cabnal (tree 1)		June 30		Green		10.00	1.0160	14.20	58.98	26.56	70.69	.....	1.38	21.48	.....	.....	Do.
180	.....do		....do	July 9	.....do	Green, slight brown.	11.90	.9983	15.19	63.72	20.83	71.32	.....	1.27	21.06	.....	.....	Do.
171	Cabnal (tree 2)		....do		Green, brown spots.		9.48	1.0267	16.66	55.84	27.60	75.98	.....	1.29	16.09	.....	.....	Do.
172	.....do		....do	July 12	Light green	Green, dark brown spot.	10.40	1.0103	14.33	60.80	24.54	75.23	.....	1.29	16.26	.....	.....	Do.
145	Tertoh	44856	May 5		Purple dark green.	Purple, brown	19.95	.9328	9.53	79.86	10.29	88.34	.92	1.60	4.38	.47	1.05	Immature.
170	.....do		June 30	July 12	Green purple.	Purple	14.76	.9314	11.89	70.99	17.12	83.46	.....	1.25	8.34	.....	.....	Poor sample.
143	Kanola	43560	Mar. 8	Mar. 23	.....	....do	7.7	.....	12.27	63.64	23.67	70.22	1.32	.....	21.91	.49	.....	Mature.
144	....do		Apr. 6	Apr. 9	One-half purple, one-half green.	Three-fourths purple, one-fourth green.	7.1	.9941	15.10	63.36	21.54	71.50	.....	.97	20.91	.62	1.25	Do.
159	Chilean seedling.	43475	.....	May 24	Light green	Bright green	10.78	.9197	13.67	68.37	17.97	79.20	1.24	1.66	13.21	.57	.....	Maturity doubtful.
201	.....do		Aug. 22	Aug. 25	Dark green	Dark green	13.9	1.0089	7.56	77.33	15.11	73.30	.....	1.99	18.57	.....	.....	Mature.

[1] All these varieties were located at Duarte, with the exception of sample No. 145, located at La Crescenta, Nos. 143 and 144, located at Monrovia, and Nos. 159 and 201, located at Whittier.

DISCUSSION OF RESULTS.

COMPOSITION OF STANDARD VARIETIES TESTED.

The averages of the analyses of the standard varieties of the avocado can not well be used as a basis for comparison, for the reason that samples from some trees were taken while the fruit was immature and those from other trees only when the fruit had become almost ripe. Table 1 was arranged, therefore, to show the order in which each variety ranked with respect to each constituent. The rank is based on either the maximum or minimum figure obtained. The maxima are given in the case of weight, edible matter, protein, and fat; the minima in the case of skin, seed, and crude fiber. When the differences are small, these figures should not be given too much weight, as the relative position of the variety might be changed by another set of data obtained from trees differently located. It might be better, therefore, to rank the varieties by groups only.

When mature, Sharpless, Spinks, and Blakeman average well over a pound to the fruit; Lyon, Fuerte, Taft, and Dickinson, while often reaching a pound in weight, average less, usually about 13 or 14 ounces. Puebla averages about 8 ounces in weight.

Fuerte and Sharpless have the greatest proportion of edible matter, more than 80 per cent. Lyon, Blakeman, Puebla, Spinks, and Taft have between 70 and 80 per cent.

Puebla and Fuerte show less than 6 per cent of skin; Blakeman, Spinks, Sharpless, Taft, and Lyon range from 7 to 10 per cent; and Dickinson exceeds 18 per cent.

Fuerte and Sharpless have the smallest seeds, with Dickinson and Lyon next, each of the four varieties having less than 10 per cent of their weight in seed. Taft and Blakeman run below 15 per cent, while Spinks and Puebla exceed that figure.

When protein is considered, Lyon is the outstanding variety, having more than 4 per cent. In any attempt to increase the protein content of the avocado by bud selection, therefore, this fruit must be considered. When mature, it contains more protein than any other variety yet examined. Spinks, Fuerte, Puebla, and Blakeman are rich in protein, having more than 2 per cent, while the remaining three varieties fall below that figure.

Fuerte leads all other varieties in fat content at maturity, having almost 30 per cent. Lyon and Puebla are also very rich in fat, the best samples containing over 25 per cent. Blakeman, when mature, runs over 20 per cent, while Spinks, Sharpless, and Taft are just below that figure. Dickinson is low in fat, the best sample having less than 15 per cent.

Taft has the smallest amount of fiber, the best sample showing less than 0.75 per cent. Sharpless and Spinks contain a little over 1 per

cent. Puebla, Lyon, Dickinson, and Blakeman have less than 1.25 per cent, Fuerte being the only variety to exceed that amount.

CORRELATION BETWEEN MATURITY AND COMPOSITION.

Even a superficial study of the tabulated data reveals many interesting relations between the composition of the fruit and its maturity. The greatest problem in maturity investigations, however, is the correlation between physical appearance and composition. As a rule it is not hard to decide fairly accurately from its composition at what stage of growth a fruit is in its optimum condition. It is comparatively difficult, however, to correlate this stage with some physical aspect, particularly when the optimum condition desired necessitates the gathering of the fruit some time before it is to be eaten or preserved. All fruit reaches a stage where its maturity is manifest from the physical appearance, but usually when this stage is reached the fruit has passed the optimum condition for long shipment and perhaps even for storage. For instance, when cantaloupes have begun to develop a yellow color on the vine, the time is past when they can be satisfactorily shipped for long distances, and coloring on the tree marks the time when Bartlett pears have passed their best condition for shipping and storage.

Purple or black avocados change in color during growth. An extended study of these varieties might show some correlation between their color and their composition. In the case of green-colored fruit, however, such an opportunity is not afforded. Neither kind can be left on the tree until soft enough to eat, with satisfactory results, for besides the loss of time there is also a noticeable loss in flavor.

The color of the stem has been suggested as an indication of maturity. This may be practical with some varieties, but so far the experience of the authors has led to no definite conclusions in this matter. The stems of some decidedly immature fruit are yellowish, while those of others are green after the fruit has reached a satisfactory state for picking. As far as physical appearance is concerned, it has been impossible to correlate closely any single character or set of characters with maturity.

There is, however, a definite correlation between some other characteristics and ripeness. Thus, the time which elapses after picking, until the fruit becomes sufficiently soft to be edible, roughly indicates whether or not it was in a satisfactory condition when picked. Data in Table 4 show that during growth there is a sharp decline in the time necessary for this softening, but the chart (fig. 1) shows that this change is seldom correlated with the fat content. For instance, in the case of the Fuerte, in February the period elapsing between the time of picking the fruit and the time when it was soft was only 6 days, whereas before that time this period had been from 11 to 16

days. The rapid increase in fat content of this variety, however, ceased in December, and it seems evident that the fruits were in as good condition for eating at that time as in February. On the other hand, the Taft required only 6 days for softening in March, compared with 12 to 19 days in the previous months. The maximum fat content here was not reached until May, however, and the fruit was perhaps ready to eat in April. The Lyon sample for March required 8 days to soften, whereas previously from 12 to 19 days had been required. The maximum fat content was not reached until May, and the fruit was not in satisfactory eating condition until April. It would thus appear that the period required for softening is only an approximate indication of a satisfactory condition for harvesting.

While the fruit of several of the standard varieties was not available in sufficient quantities for satisfactory completion of the tests, enough data were secured from the analyses of Fuerte, Lyon, and Taft to throw some light on the changes which took place as the fruit matured.

Specific gravity of the fruit does not vary with maturity. With one of the varieties there is a possible tendency toward a lower specific gravity in the samples as the fruit becomes thoroughly mature, but this is not the general rule. For instance, with the Fuerte, both the fresh and storage samples tend to decrease in density as the season advances. Starting with a specific gravity of 0.99 or 1, they decrease in a more or less irregular way until the final samples show a density of about 0.96. Most of the other varieties, however, show no such tendency, and it may even be said that the tendency is toward an increase in density as the season advances.

The edible matter increases in all varieties as the fruits mature, but there seems to be no satisfactory line of demarcation which indicates maturity.

The amount of moisture, of course, varies inversely with the amount of fat and therefore decreases with maturity.

The percentage of ash in avocados is relatively small. While it increases with maturity, it is hardly possible to formulate a test with this figure as a basis.

Protein is also higher later in the season than when the fruit is immature. This constituent seems variable, however, and therefore less available for standardizing purposes.

The fat or oil of the avocado, of course, is its chief constituent, and when it has reached its maximum there is no doubt that the fruit is mature. The question arises, however, as to how long before this point is reached the fruit can be harvested with satisfactory results as far as eating and storage qualities are concerned.

When sampling could begin soon enough, the fruits showed a consistent and more or less uniform increase in fat up to a certain point, after which the increase was much less (fig. 1). Often, late in the season, apparent decreases are indicated, showing at least that the increases were not sufficient to overcome the variability of the samples. In the limited experience of the authors, it would seem that the point where the uniform increase in fat ceases is about the point where a satisfactory maturity is found. With the Fuerte this occurred in December, with the Puebla in February, with the Lyon in May, with the Blakeman in May, with the Spinks in March, with the Taft in May, and with the Sharpless in April or earlier. The Dickinson samples afford no data on this point, as the sampling ceased before the fat content had become constant.

The reducing substances or sugars in the pulp of the avocado decrease markedly as the fruit ripens, but the range is hardly sufficient to be of use in estimating maturity. Little or no sucrose is present in avocado pulp.

The crude fiber changes but little during the growth of the fruit, such changes as take place probably being due to the variability of the other constituents. From the data given in Table 3, showing the actual content of fat on a water-free basis, however, it is evident that at the time the rapid increase in fat ceased, the percentages on a water-free basis in the different varieties were, with one exception, close to 70. The following are the figures: Blakeman, 70 per cent; Dickinson, 60 per cent; Fuerte, 75 per cent; Lyon, 70 per cent; Puebla, 73 per cent; Sharpless, 72 per cent; Spinks, 68 per cent; Taft, 72 per cent. It might be supposed from these data that Dickinson was not yet mature, inasmuch as sampling stopped at this time, but miscellaneous samples harvested even later the following year showed a lower content of fat than was shown by these samples. Experience with fully matured fruit of other varieties indicates that avocados rich in fat usually contain at least 70 per cent on a water-free basis, but the rule does not hold when the fat content at maturity is low.

One other source of information concerning changes taking place while the fruit is ripening is afforded by the comparison of the data resulting from the analysis of the fresh and storage samples. When these data are confined to the edible portion of the fruit, the differences are more striking after the data have been reduced to a water-free basis (Table 3). Many interesting phenomena are revealed by a close study of these results. Some of them may be the result of errors in the analyses or of the natural variability in samples consisting of but two or three fruits, but most of them are undoubtedly the result of changes in composition of the fruit after it is removed from the tree. It is hardly practicable to analyze part of one fruit and

store the remainder until it has softened before analyzing it. The best that could be done was to select a lot containing from two to six fruits, as nearly uniform as possible, analyze half this number as soon after picking as possible, and hold the other half until they had become soft. The data must therefore be considered in the light of these facts. Where, however, changes are almost always in one general direction, the probability of their being the result of individual variation is remote.

In all, 40 samples were analyzed at once and after storage, the number being distributed among immature and mature fruits. Some difference between the specific gravity of the fresh and storage fruits of many varieties is shown. In some varieties the storage samples have a much lower specific gravity than the fresh, but in other varieties the reverse is true. Peculiarly enough, also, the position in each type when the fruits are thoroughly mature shows a tendency to reverse itself. Cases in point are the Taft, six samples of which were examined, and the Fuerte, eight samples of which were examined. The Taft samples in September had the same specific gravity, but in October, November, and December fresh samples had a higher gravity than the storage samples picked at the same time, while in May and June the reverse was true. The Fuerte samples for September also had approximately the same specific gravity. The October, November, December, January, March, and April samples of fresh fruit, however, had a lower specific gravity than the storage samples, while in May the reverse was true. Also in the case of the Lyon the fresh samples showed a higher specific gravity until June, when the storage samples had the higher density. On the other hand, the Puebla samples always showed a difference in specific gravity, the soft samples having the higher. Unfortunately, the samples were exhausted before thorough maturity was reached, so that any change late in the season escaped observation. The December samples of the Spinks showed a higher density in the fresh sample, after which the reverse held true.

Omitting the data on the Blakeman, only one double sample of which was examined, the varieties having the heavier skins (Dickinson, Lyon, and Taft) have higher densities in the fresh samples. The thin-skinned fruits (Fuerte, Puebla, and Spinks) show a higher density in the case of the storage samples. Sharpless also is rather thin-skinned, but acts in this respect like a thick-skinned variety.

In several cases the pulp or edible matter increased during storage of the samples. Two factors may account for this—individua variation in the fruit and inability to separate satisfactorily the skin and the pulp in the very green samples. In this connection it will be noticed that the proportion of skin in the storage samples is almost always lower than that in the fresh samples. Of the 40

double samples, the storage fruit had 11.2 per cent of skin and the fresh fruit 13.8 per cent. As the moisture in the pulp was about the same between the two sets, this shows that any loss in weight on standing is largely due to loss of water from the skins.

The proportion of seed is somewhat higher in the storage samples than in the fresh, about 0.8 per cent, being 15.2 for the fresh and 16. 0 for the storage. The loss of water from the skin, which increases the relative proportion of the seed, probably is the cause.

The percentage of water in the pulp varies but little. The 40 double samples show about 0.7 per cent more water in the storage than in the fresh samples, a quantity which is probably negligible, as it amounts to only 1 per cent of the moisture content. The percentage of ash is higher by approximately 10 per cent in the storage samples than in the fresh. The only way to explain this discrepancy, which is too large to be accounted for by variation in the samples, is by the difficulty of separating the pulp and skin of the very immature fresh samples. The greater portion of ash in the pulp of the avocado lies next to the skin. If more of the pulp of the fresh samples were left adhering to the skin, less ash would be apparent in the remaining pulp. This difficulty is not encountered in the soft samples, as the pulp is more readily separated. The fact that the greater ash content is nearer the skin, found true in many fruits, has been confirmed in the case of the avocado by analyses made in the laboratory, which showed the outer half of the pulp next to the skin to have 1.54 per cent of ash, as compared with 1.36 per cent of ash in the inner half next the seed, the same avocado being used for each determination.

The protein content shows a somewhat similar change, the average content for the storage samples being approximately 1.8 per cent, while the fresh samples contain but 1.6 per cent. Calculation to the water-free basis does not alter the general ratio between the protein contents of the samples. Another peculiarity of the data is the uniform increase in the protein content of the storage samples of immature fruits over that of the fresh samples. This is particularly noticeable in the case of the Lyon, where the average increase in protein of the storage samples over the fresh is more than 0.4 per cent. With some of the other varieties, this increase is more marked in the case of the immature fruits; after maturity there is in many cases little change, and in some a reverse condition is true. Taking it all in all, the results are inconclusive. It is hard to conceive of a condition where the actual nitrogen content of the fruit could be increased after removal from the tree.

There also seems to be a decided increase in fat content in the storage samples when the fruit is immature, an increase which is not maintained after maturity has been reached. At present it is not

clear whether this is the result of chemical changes occurring during storage or merely of the loss of some other constituent in the fruit. In this connection it is to be noted that the loss of sugar accompanies the increase in fat content and that there is also a decrease in undetermined matter in the storage samples. These losses are not always uniform, however, or in proportion to the increase in fat. When it is recalled that the analyses were necessarily made on different fruits, small inconsistencies can be explained by individual variations in the fruits. The loss is not due wholly to evaporation of water, for the differences are maintained when the data are stated on the water-free basis.

There is some loss in weight in avocados on storage, but the loss of water by evaporation from the pulp is offset by the decomposition of other material. Undoubtedly sugar or at least substances of similar nature are transformed rapidly and are no longer calculated as sugar when the immature fruit is allowed to soften. Such changes often amount to well over 50 per cent of the sugar found. This subject will need further careful study before many questions can be answered. As far as the present investigation goes, it is sufficient to conclude that there appears to be a decided increase in fat content and decrease in sugar content and undetermined matter during the storage of immature avocados. These changes are less marked in the case of the storage of mature fruits, which sometimes show a reversal in the order of the change.

With the amount of work so far accomplished, it is impossible to attempt to recommend a maturity standard on any of the varieties of the avocado. The work here reported covers but one season and one locality for each variety. The data on several of the varieties are decidedly meager.

In the search for promising seedlings and varieties, many miscellaneous samples have been examined in the Laboratory of Fruit and Vegetable Chemistry. Samples of special interest are those of the Guatemalan varieties introduced by the Office of Seed and Plant Introduction of the Bureau of Plant Industry, not a few of which are now in bearing in California.

These samples, the results of the analysis of which are given in Table 6, include the following varieties: Pankay S. P. I. 44785, Benik S. P. I. 44626, Mayapan S. P. I. 44680, Cantel S. P. I. 44783, Nimlioh S. P. I. 44440, Lamat S. P. I 43476, Cabnal S. P. I. 44782, Tertoh S. P. I. 44856, Kanola S. P. I. 43560, and a Chilean seedling S. P. I. 43475. Of these Pankay, Benik, Mayapan, Lamat, and Cabnal were mature in May, when the first samples were obtained. Cantel and Tertoh were not mature at that time, and there is some doubt as to the maturity of the first samples of Nimlioh. Kanola had every appearance of being mature in February. The second sample of

Tertoh was poor and possibly immature. As will be seen from the table, several of the varieties are rich in oil. Of these Cabnal was believed to have the best flavor. Kanola, while small, also has a good flavor and possibly matures as early as February, when the markets are not glutted with fruit. The protein content of these importations is lower than that of the standard varieties developed in California. They have the heavy skin of the Guatemalan types, which is possibly a marked advantage when shipping quality is considered. The seeds in a number of them are also larger than the average seeds of the types developed in California. All of these fruits are from young trees, and possibly some of the characteristics will be modified as the trees develop.

The analyses of other California types and seedlings are given in Table 5. Many of these are seedlings which have not yet been grown by vegetative propagation, so that it is of little use to comment on their quality. The data, however, are of value to those who are seeking promising experimental material.

CONCLUSIONS.

No satisfactory correlations between physical properties and maturity have been found in the avocados examined.

The proportion of many of the constituents of the avocado changes during its development, the most marked change being the increase of the fat content. This takes place rapidly while the fruit is immature, and much more slowly as it approaches maturity, with possibly a slight decrease if the fruit remains too long upon the tree. It is accompanied by a decrease in sugar content.

Fruits rich in fat (above 20 per cent) contain at least 70 per cent of that constituent on a water-free basis at maturity.

On storage of immature fruits there is an apparent increase in the proportion of fat, accompanied by a decrease in the sugar content and undetermined matter.

Mature fruits on storage do not show this increase to the same extent, and at times show some loss.

No standards of maturity are recommended.

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